Smart Wind Farm Management Based On Wsn

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Article History: Received: 11 January 2021; Revised: 12 February 2021; Accepted: 27 March 2021; Published online: 10 May 2021

Abstract: Super Grid Lead Node Path, Partitioned Grid Lead Node Path and Shortest Super Grid Lead Node Path are the three network operations proposed for efficient routing. The grid lead node is selected by calculating their value of node degree and the node degree value is relied upon the metrics such as distance, energy and the communication range. Operation of the network in all three proposed protocols SGLN, PCLNP and SSGLN undergoes some particular number of communication rounds. The grid lead node is selected by calculating the energy values. The proposed mechanism includes GL selection, SGL selection done using fuzzy logic with the metrics such as implicit distance and implicit energy. MST is applied for route establishment and finally data transmission is processed. GL election is done based upon distributed manner and SGL selection is done using centralized process. Simulation results proved the efficiency of the proposed protocols compared to their conventional TLCRA scheme.

Keywords: Grid Lead, Super Grid Lead; Implicit energy; Implicit distance; Fuzzy logic; WSN.

1. Introduction

Wireless Sensor Network (WSN) makes the network communication optimal by forwarding the sensed data to the targeted region. Therefore WSN is a promising solution for critical applications and that observes the physical and environmental conditions regarding humidity, temperature, pressure etc [1]. WSN has large number of tiny sensors distributed spatially over the regions. The physical parameters of the environment are analysed by the located nodes and acquires the information from the region and distributed to the Base Station (BS) or to the specified targeted nodes done over the air medium through which the current progression activities are monitored. Also, typical and hierarchical clustering that includes grid-based, chain-based, area based routings is done in WSN for making it energy efficient [2, 3].

Since nodes are battery powered and network longevity of deployed nodes are falls under the utilization of energy i.e. battery power [4]. Therefore this work is concentrated on proposing a grided and super grided network for making the network as energy efficient for transmitting the sensed information.

2. Related Works

Numerous works related to energy efficient griding protocols for the applications like health monitoring, military surveillance, wind turbine etc. However, the conventional works still faces the energy inefficiency issues and some of them are discussed below.

Tri-level Clustering and Routing Protocol (TCRP) was proposed to monitor the offshore farm of wind turbine control [6]. Here the Cluster Head (CH) gathers information from the single deployed nodes and forwards the same to the BS however in multi-hop transmission the CH is loaded heavily and this process increases energy drain rate and makes the CH dead very earlier and hence to overcome this issue multi-level routing protocol was proposed [7]. This protocol includes more number of hierarchical layers that minimizes the node count that is added for long range communication. Mode Switched Grid-based Routing (MSGR) for WSN is proposed here Grid Head (GH) is selected in each grid and this GH is used to transmit the data to BS. Here GH can be switched between active and sleep modes alternatively [5].

Fuzzy based Two Level Adaptive Clustering and Routing Protocol (FTLACRP) was proposed [8]. CHs are chosen on basis of node degree remaining energy level and centrality in primary and in secondary level the Super Grid Heads (SCH) are elected using the metrics like centrality and mobility. FTLACRP adopts multi-level routing to improve the network performance and stability period. However this mechanism is dealt with data traffic issues. To resolve this problem centralized mechanism of selection of CH process in the grid members was considered with the parameters like centrality, remaining energy and node degree [10]. Grid Based Reliable Routing (GBRR) technique was proposed to achieve reliable routing in WSN. Here the virtual clusters are created on the basis of square grids and next hop decision is made using intra and inter clusters communication [9].

Hybrid Partitioned Multi-hop Routing (HPMR) protocol was proposed here the monitoring field is divided into numerous partitions called as grids and these grids are called as grids [11]. Here CH is selected

using multi-stage cluster algorithm that optimizes the energy efficiency [12]. Here CH transmits data to BS with the help of Minimum Spanning Tree (MST) path.

Two Level Clustering and Routing Algorithm (TLCRA) was proposed [13], the grid heads are selected using chain based selection process and the sensed information is routed through the MST route, thus the consumption of energy is minimised. To reduce the energy consumption and network traffic, Energy Aware Grid Routing (EAGR) was proposed for the cluster based routing protocols [14].

3. Proposed Methodology

Two stage clustering approach based on grid style is proposed here for developing an efficient and shortest route from sender to base station. Implicit distance and implicit energy are the two metrics used to identify the super grid lead node. This metrics are given as input to the fuzzifier using fuzzy logic. The three proposed network operations of this two-stage clustering process are (i) Selection of Super Grid Lead Node (SGLN) route (ii) Partitioned Super Grid Lead Node (PSGLN) route and (iii) Shortest Super Grid Lead Node (SSGLN) are the three network operations proposed for efficient routing. The grid leads in each grid is selected based on the residual energy and the node which have high leftover energy is selected as Grid Lead (GL) node among the grid members. Once the grid lead from all the grids is selected one Super Grid Lead (SGL) node is selected to communicate with the BS. The SGL is selected by applying fuzzy logic and the input parameters taken for identifying SGL are implicit distant and implicit energy. The nodes present under the communication range are grouped together to form grids in the network. The three proposals include selection of SGL, partitioning SGL and selecting shortest SGL path are done for transmitting the data efficiently towards the BS.

Fuzzy approach is applied in the process of electing GL node from all the grids. Implicit_Energy (I_E) and Implicit_Distant (I_D) are the input parameters used to select SGL and this fuzzy model is applied with fuzzy inference system for fuzzification and de-fuzzification process. Rule based fuzzy model is applied to detect the GL from all the grids and SGL calculates minimum hop-count towards the BS for transmitting the data.

Consequently all the nodes that present in the grid should compute the node distant (I_D) with respect to the $d_o(Ni)$, along with maximum distant nodes (d_{Mx}) and minimum distant nodes (d_{Mn}) given in equation 1, then the I_E among all the nodes present currently is computed by taking difference between the initial energy and current energy level of the node and it is given in equation 2.

$$I_D = \frac{d_o(Ni) - d_{Mn}}{d_{\mathrm{Mx}} - d_{Mn}} \tag{1}$$

$$I_E = Ni\left\{\frac{E_{initial\_} E_{current}}{Ni}\right\} \tag{2}$$

Triangular membership function is applied to avoid computation burdens for generating the fuzzy sets. The nodes that present in the grids has their energy levels and some distant is exists among the nodes. Therefore the fuzzy sets is generated by using this parameters such as energy and distant. Based on the linguistic variable and membership value the nodes are selected as SGL. The linguistic variables that are taken here for considering I_E such as low, mean, high and for I_D the considered linguistic variables are near, far and adequate. For selecting the SGL five linguistic variables such as low, very low, medium, high, and very high are considered. In common heuristic data is used to generate fuzzy rules. Therefore the reliable SGL with high leftover energy and low distant node towards BS is elected by using fuzzy rules with high leftover energy and shortest distance towards the sink. Therefore the SGL nodes is elected if the linguistic variable {SGL → very high & high} for the fuzzified output. SGL is determined using equation 3.

$$SGL \leftarrow FIS(Ni.I_E, Ni.I_{D)}), 1) \tag{3}$$

Table 1: Fuzzy Rules

S.No	I_D	I_E	RFCL
1	Near	Low	Medium
2	Adequate	Low	Low
3	Far	Low	Very low
4	Near	Mean	High
5	Adequate	Mean	Medium
6	Distant	Mean	Low
7	Near	High	Very high
8	Adequate	High	High
9	Distant	High	Medium

This super GL node selection using fuzzy logic is limited with (0, 1), this approximates the computed node distance for all GL and facilitates the suitable power level in order to transmit the data towards the sink. Table 1 gives the output of selection of SGL with respect to the implicit energy and distance values.

a. SGLN

Initially one GL node is chosen from all the grids and Super GL node is chosen to transmit the sensed data towards the BS. The node can be elected as CL on basis of their residual energy in each round of data transmission. The SGL is selected with the help of fuzzy logic and each node will get the chance to become GL and SGL since the energy gets balanced in each set of data transmission. The opportunity of GH_role is broadcasted to all the nodes presented in the grid and if a node is found with higher residual energy then the node is selected as GL, then GL_Elect message is announced to other grid members presented in the grid. This procedure is carried out in all other grids and GL is selected in all the grids simultaneously. By applying fuzzy approach the super GL node is selected from the selected cluster lead nodes. The grid members send the data to their respective GL by sending the joint request message GL_JOIN_R_Q to GL. Then the GL's from all the grids send their implicit energy and implicit distance values to the BS for selecting SGL through the request message as Select_SCL_R_Q. Figure 1 shows the SGLN process.

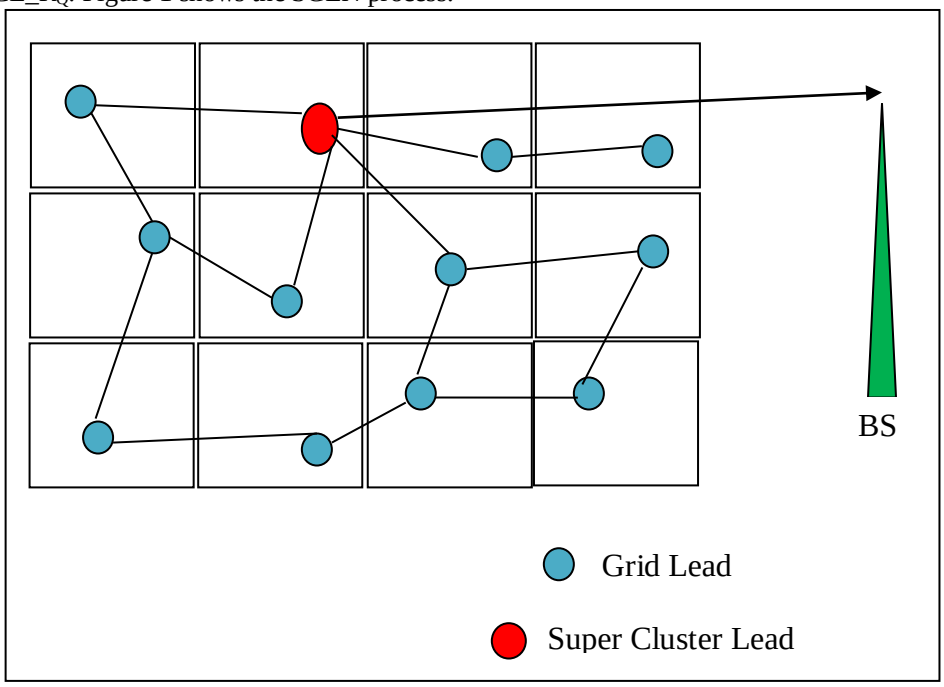

Figure 1: SGLN

b. PSGLN

The entire network is partitioned into several numbers of super grids and each super grids consists of grid members, grid lead and super grid leads. To make the network energy efficient the grids are again divided into smaller portions. In this scheme Therefore for each grid one GL is selected and for each super grid one SGL is selected for data transmission. Therefore 'K' number of SGL's is selected if 'M' number of partitioned super grids (process of PSGLN) is found in the networks. Here in the partitioned PSGLN proposal the grid members send their data to the GL and the GL's from each grid send their collected data to SGL. Finally SGL's from the each super grid are directly sent their collected data to the BS as shown in figure 2.

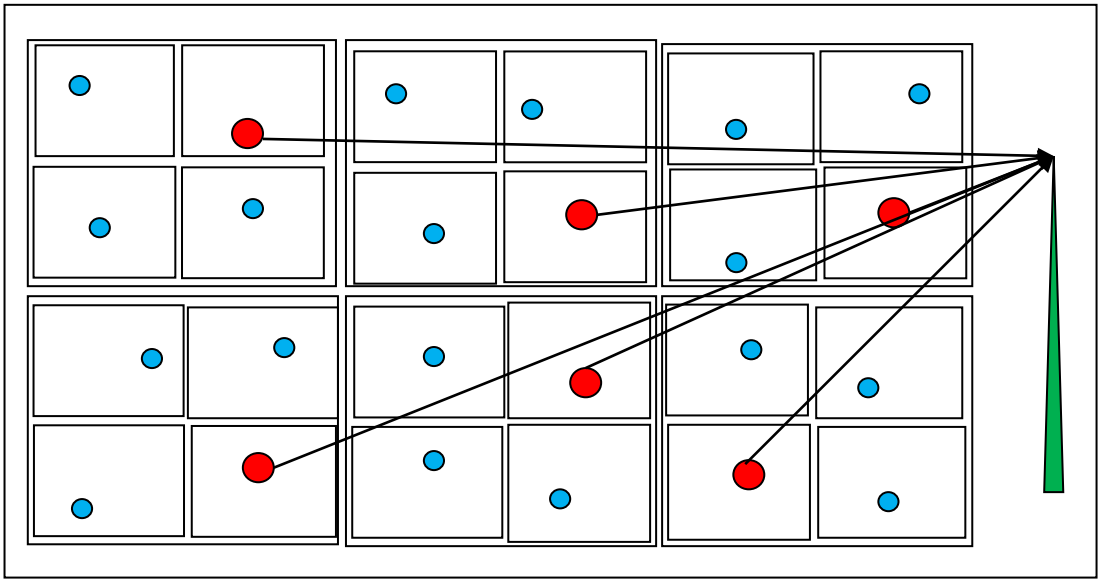

Figure 2: PSGLN

Selection of GL's in PSGLN process is similar to the SGLN process, here also fuzzy logic with rule based model is applied for selecting SGL in super grids. BS computes the SGL_chance for each super grid by using fuzzy logic selects the SGL with max SGL_chance for electing as SGL and this selected SGL's collects the data from the grid lead nodes and transfers to the BS directly in individual.

c. SSGLN

The entire network is partitioned into several numbers of super grids and each super grids consists of grid members, grid lead and super grid leads. To make the network energy efficient the grids are again divided into smaller portions. In this scheme Therefore for each grid one GL is selected and for each super grid one SGL is selected for data transmission. Therefore 'K' number of SGL's is selected if 'M' number of partitioned super grids (process of PSGLN) is found in the networks. Here in the partitioned PSGLN proposal the grid members send their data to the GL and the GL's from each grid send their collected data to SGL.

Selection of GL's in SSGLN process is similar to the PSGLN process, and same fuzzy logic with rule based model is applied for selecting SGL in super grids. Based on SGL, BS develops a minimum spanning tree path for transmitting the data. MST is constructed by broadcasting the message Tree_B'Cast presented in the super grids. The channel used here to forward the sensed data is Time Division Multiple Access (TDMA) in which the time slots are fixed so that the collisions can be reduced. Finally, SGL constructs a MST path with minimum hop_count towards BS and the data is transmitted through this path. Figure 3 shows the SSGLN process.

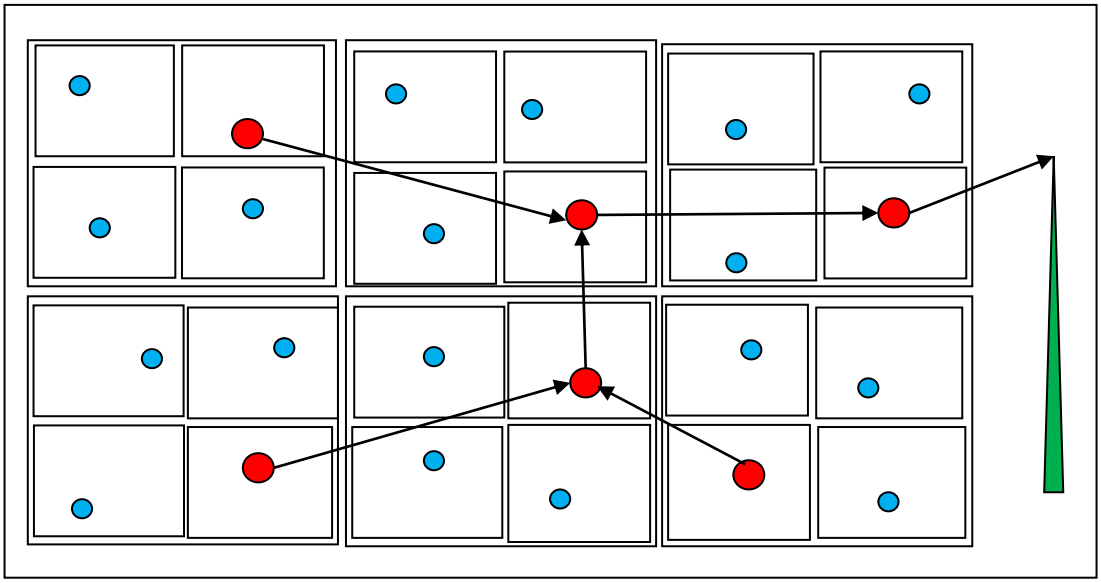

Figure 3: SSGLN

4. Results and Discussion

The simulation analysis of the proposed mechanisms such as SGLN, PSGLN and SSGLN and the conventional TLCRA scheme are analyzed using the simulation tool named Network Simulator 2.35. It is

possible discreetly to examine the events in a network scenario. To assess the network performance the Packet Delivery Rate (PDR), network lifetime, delay and residual energy performance of the network before and after adopting the proposed system.

The simulation results are analyzed for all the three proposed mechanisms called SGLN, PSGLN and SSGLN and the conventional TLCRA.

a. PDR

PDR is defined as the packet rates that are delivered to the base station successfully with respect to the sum of number of packets sent by the particular sender.

Delivery rates for the proposal of SSGLN model achieves good result when compared to conventional scheme of TLCRA and it is shown in figure 4. The PDR unit is measured in bits per second.

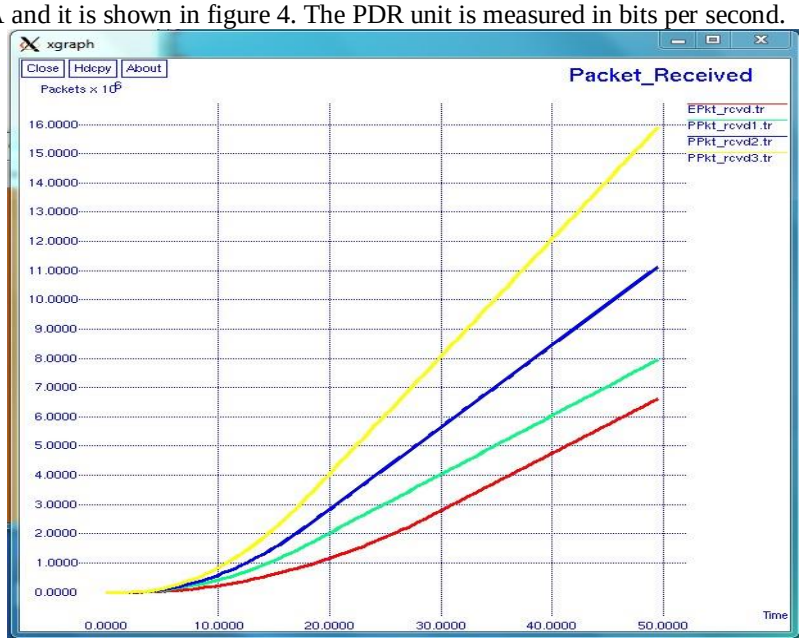

Figure 4: PDR

b. Delay

Delay is generally computed by estimating queuing time, sensing time and processing time from sending process to the ending process.

Figure 5: Delay

Delays of existing TLCRA and proposed methods are measured and plotted in figure 5. It is shown that the SSGLN process has obtained lower delay values since they are the averages of each data processing time.

c. Network lifetime

The network lifetime is measured to prove network reliability in terms of all parameters. Figure 6 shows the network lifetime of the three proposed such as SGLN, PSGLN and SSGLN and the conventional TLCRA. The SSGLN approach has better network lifetime since the SGL nodes forwards their data by taking MST route greatly reduces the redundant network operations.

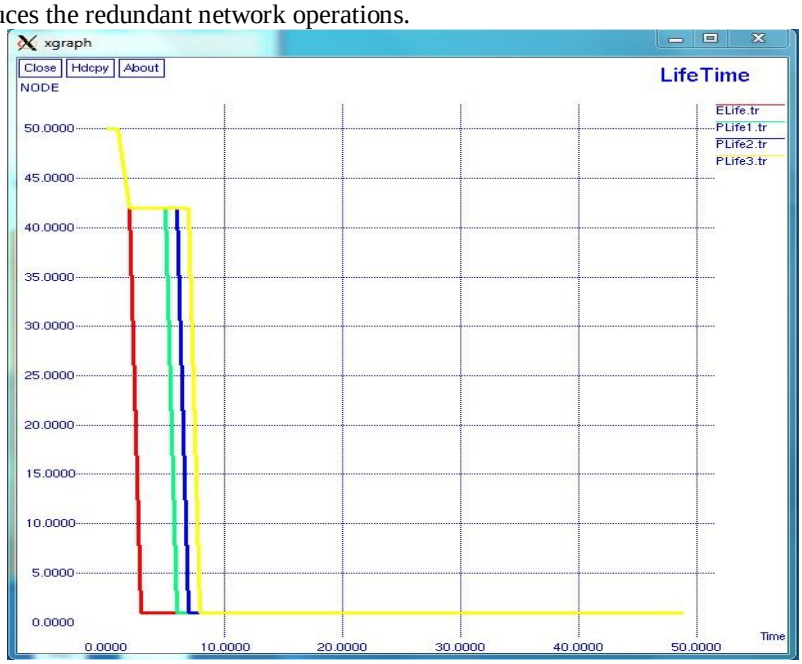

Figure 6: Network Lifetime

d. Residual Energy

The amount of energy that is leftover in a node at the current instance of time is called as residual energy. A measure of the residual energy gives the amount of energy that is left in the node for further network operations.

Figure 7 shows the residual energy for proposed SGLN, PSGLN, SSGLN and conventional TLCRA schemes. The third proposed approach SSGLN has obtained good leftover energy compared to other schemes.

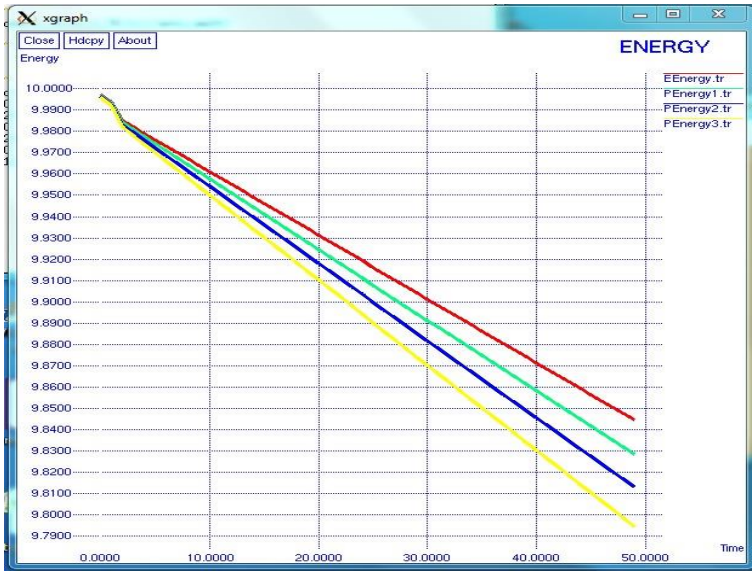

Figure 7: Residual Energy

5. Conclusion

Three proposal mechanisms such as Super Grid Lead Node route, Partitioned Grid Lead Node route and Shortest Super Grid Lead Node route are implemented here for efficient routing in WSN. The grid lead node is selected by calculating the energy values and it is relied upon the metrics such as implicit distance and implicit energy. This proposed protocol SGLN, PSGLN and SSGLN are divided into several communication rounds. The proposed mechanism includes GL selection, SGL selection done using fuzzy logic and route establishment and finally Data transmission. GL election is done based upon distributed manner and SGL

selection is done using centralized process. Simulation results proved the efficiency of the proposed protocols compared to their conventional TLCRA scheme.

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